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Traceable RFID Tag Performance Measurements

Dr Hui Shao
JX Instrumentation Co Ltd

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Agenda

- About JXI
- Traceable Tag Measurement Theories
- Traceable Measurement Practices
- Conclusion

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About

JX Instrumentation

- Modular Instrumentation Company
  - RFID, Radio Monitoring Systems and Modules
- World Class Team
  - Strong R&D Investment since 2004
  - Qualified RFID Testers
  - Standard Work Group Member
  - 200+ RFID Test Systems Sold to 100+ Customers
  - Office in Shanghai, Beijing, XiAn, Guangdong, Chongqing, Chengdu
  - Partners in Japan, Austra, Korea, US…

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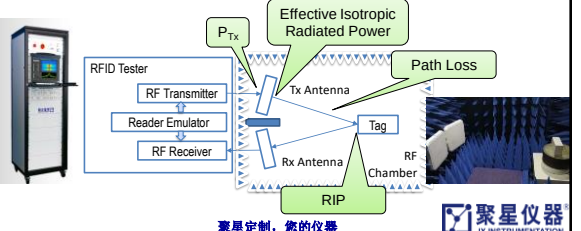
Theory

800-900MHz Tag Sensitivities

- Received Isotropic Radiated Power (EPC)
  - $RIP(dBm) = EIRP - PL$
  - $EIRP = P_{Tx} + G_{Tx}$



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800-900MHz Tag Sensitivities (cont.)

- Magnetic Field Threshold (ISO 18046-3)
  - $E(V/m) = \frac{\sqrt{30*EIRP(W)}}{R(m)} = \frac{\sqrt{P_{Tx}(W)*G_{Tx}}}{R} * 5.477$
  - Measure P_{Tx}, Calibrate G_{Tx}
- Field Strength is derived from Radiated Power

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Free Space Path Loss (FSPL)

- $P_{Rx} = P_{Tx}G_{Tx}G_{Rx}\frac{Ae}{4\pi R^2}$
- $Ae = \frac{\lambda^2}{4\pi}$
- $PL = \left(\frac{4\pi R}{\lambda}\right)^2$
- $PL(dB) = 20log\left(\frac{4\pi R}{\lambda}\right)$

$RIP(dBm) = EIRP - PL$

- $E(V/m) = \frac{\sqrt{30*EIRP(W)}}{R(m)} = \frac{4\pi}{\lambda}\sqrt{30 * RIP}$

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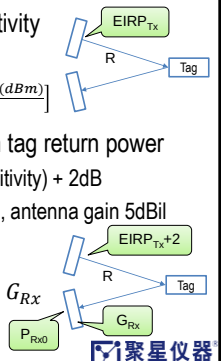
Read Range (EPC)

- Read Range, derived from sensitivity
  - Assumes reader EIRP=35dBm
  - $Range(m) = R * 10^{\left[\frac{35-EIRP_{Tx}(dBm)}{20}\right]}$
- Backscatter Range, derived from tag return power
  - Tx power = Threshold power(sensitivity) + 2dB
  - Assume reader sensitivity -70dBm, antenna gain 5dBil
  - $Range_{RL} = \left(10^{K/10}\right)^{1/4} * R$
  - $K = 110 - EIRP_{Tx0} + P_{Rx0} - G_{Rx}$
  - $EIRP_{Tx0}=EIRP_{Tx}+2$



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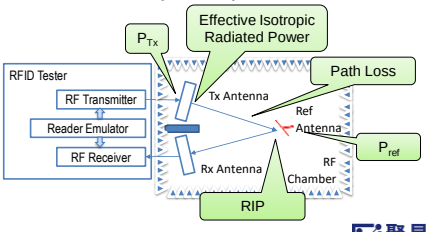
Calibration with Reference Antenna

- Tool: Reference Antenna with known Gain
  - Method 1: calibrate Tx antenna gain
  - Method 2: $RIP = P_{ref} - G_{ref}$ |P_{Tx}=threshold



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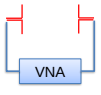
Calibration of Ref Antenna

- EPC Tag Performance Parameters and Test Methods
  - If you have 3 ref antennas (section 7.4)
  - G1+G2=S21[1,2]+PL(dB) enough if G1 is known or G1=G2
  - G2+G3=S21[1,2]+PL(dB)
  - G3+G1=S21[1,2]+PL(dB)
  - Method ref SAE ARP958



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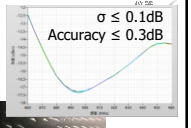
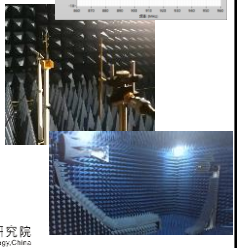
JXI Traceable Calibrations

- Working with Metrology Labs
  - China Electronics Standardization Institute
  - National Institute of Metrology
  - MET Labs
- Customers Certified
  - CNAS
  - EPC QTS





中国电子技术标准化研究院 China Electronics Standardization Institute

中国计量科学研究院 National Institute of Metrology, China

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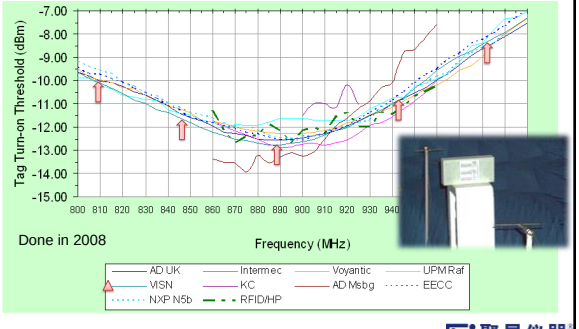
Global Compare EPCglobal TLRPP Workgroup

Practices



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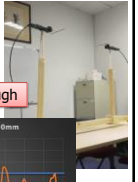
Practice: Far-field and Reflection

- Accuracy: Far-field & Reflection-free
- Office Test: Dipole 200,300…800mm
- Practical Far-field: 3λ, 1m



D²/λ may not enough

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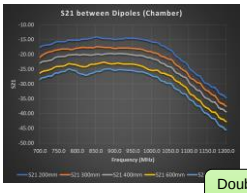
Practice: Far-field and Reflection

- Accuracy: Far-field & Reflection-free
- Office Test: Dipole 200,300…800mm
- Practical Far-field: 3λ, 1m D²/λ may not enough



Average error
- 200-300: 0.51dB
- 600-800: 0.22dB

Double side error ~1.5dB

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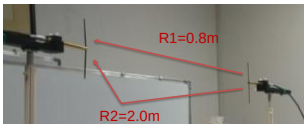
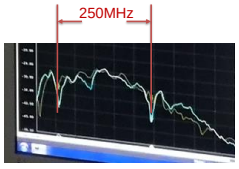
Diagnostics of Reflection

- $\Delta f = \frac{c}{\Delta R}$
  - Δf: S21 ripple period, ΔR: diff. of path length
  - Eg: $\frac{3e8}{(2.0-0.8)} = 250MHz$
- Find Reflection by ΔR





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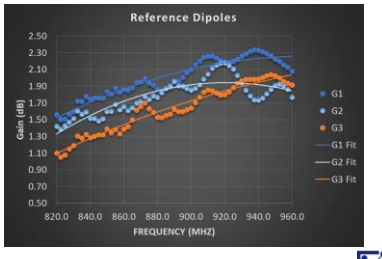
Better Calibration: Error Corrections

- Curve Fitting + Close Range Compensation
- Range Compensation for Reference Antennas Only



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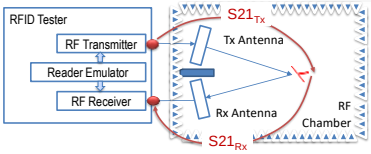
Practical Procedures

- Calibrate Reference Antenna (G_{ref})
- Calibrate RFID Tester
- Measure $S21_{Tx}$ and $S21_{Rx}$
- $RIP=P_{Tx}+S21_{Tx}-G_{ref}$

$$E(V/m)=\frac{4\pi}{\lambda}\sqrt{30*RIP}$$



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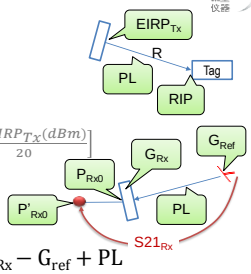
Read Range Derivation

- Read Range
  - $EIRP_{Tx}=RIP+PL$
  - $Range(m) = R * 10^{\left[\frac{35-EIRP_{Tx}(dBm)}{20}\right]}$
- Backscatter Range
  - $EIRP_{Tx0}=RIP_0+PL$
  - $P_{Rx0} - G_{Rx} = P'_{RX0} + S21_{Rx} - G_{ref} + PL$
  - $K = 110 - EIRP_{Tx0} + P_{Rx0} - G_{Rx}$
  - $Range_{RL} = \left(10^{K/10}\right)^{1/4} * R$



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JXI Traceable RFID Test Solutions

Conformance | Performance | Auto Sequence
Protocol Analyzer | Interference Analyzer
Standard Tester | Application Tester | Field Sniffer
Amplifiers | RF Switches
Antennas | Tag Emulators | Robot | Chambers

134k | 13.56M | 433M | 800/900M | 2.45G | 5.8G

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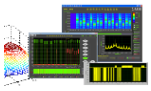
Conclusion

- Tag Tester Calibrates with Reference Antenna
- Standards:
  - Power Meter, Network Analyzer
- JXI Provides Traceable RFID Testers
  - Tag and reader, since 2005



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